

Peak-Seeking Control for Trim Optimization Project

Center Innovation Fund: AFRC CIF Program | Space Technology Mission Directorate (STMD)



ABSTRACT

Innovators have developed a peak-seeking algorithm that can reduce drag and improve performance and fuel efficiency by optimizing aircraft trim in real time. The algorithm determines a unique trim position for an aircraft by employing a time-varying Kalman filter to estimate the gradient of a performance function using in-flight measurements. Existing trim control systems pre-program position data into an aircraft's computer, based on knowledge gained from test flights and wind tunnel experiments. In contrast, this innovation determines in real time the most fuel-efficient trim surface position by taking into account actual flight conditions and an aircraft's physical condition. This customized approach results in maximum fuel efficiency for each particular aircraft.

ANTICIPATED BENEFITS

To the nation:

- **Fuel-efficient:** Reduces fuel consumption and extends the operating range of aircrafts
- **Fast:** Determines and maintains the optimum trim surface position solution with 5 minutes, despite disturbances and other noise
- **Customized:** Determines unique trim position using in-flight measurements
- **Variable:** Works on multiple effectors in multiple axes simultaneously

DETAILED DESCRIPTION

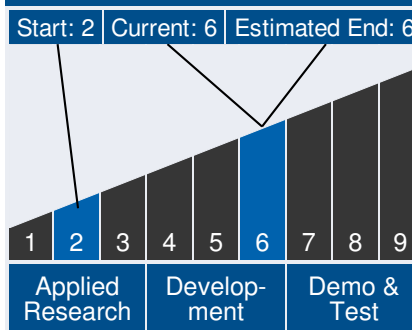
Innovators have developed a peak-seeking algorithm that can reduce drag and improve performance and fuel efficiency by optimizing aircraft trim in real time. The algorithm determines a unique trim position for an aircraft by employing a time-varying Kalman filter to estimate the gradient of a performance function using in-flight measurements. Existing trim control systems pre-program position data into an aircraft's computer, based on



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Technology Maturity



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knowledge gained from test flights and wind tunnel experiments. In contrast, this innovation determines in real time the most fuel-efficient trim surface position by taking into account actual flight conditions and an aircraft's physical condition. This customized approach results in maximum fuel efficiency for each particular aircraft.

Work to date: The Dryden team has validated the algorithm with a series of F-18 experiments.

Looking ahead: Future flight research efforts will work to further mature the technology and transition it to other aircrafts. For example, the team is current working with the U.S. Navy to study the potential benefits and costs of implementing the technology on the Super Hornet military aircraft. The group is also talking with the Navy and Lockheed Martin about testing the technology on the F-35 fighter jet.

Benefits

- **Fuel-efficient:** Reduces fuel consumption and extends the operating range of aircrafts
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- **Customized:** Determines unique trim position using in-flight measurements
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Applications

- Military jets
- Commercial airlines



1 Success Story

Management Team

Principal Investigator:

- Nelson Brown

Co-Investigator:

- Jacob Schaefer

Technology Areas

Primary Technology Area:

Demonstrate Innovative Flow Control (TA 15.3.1.1)

Secondary Technology Area:

Robotics and Autonomous Systems (TA 4)

Other Technology Areas:

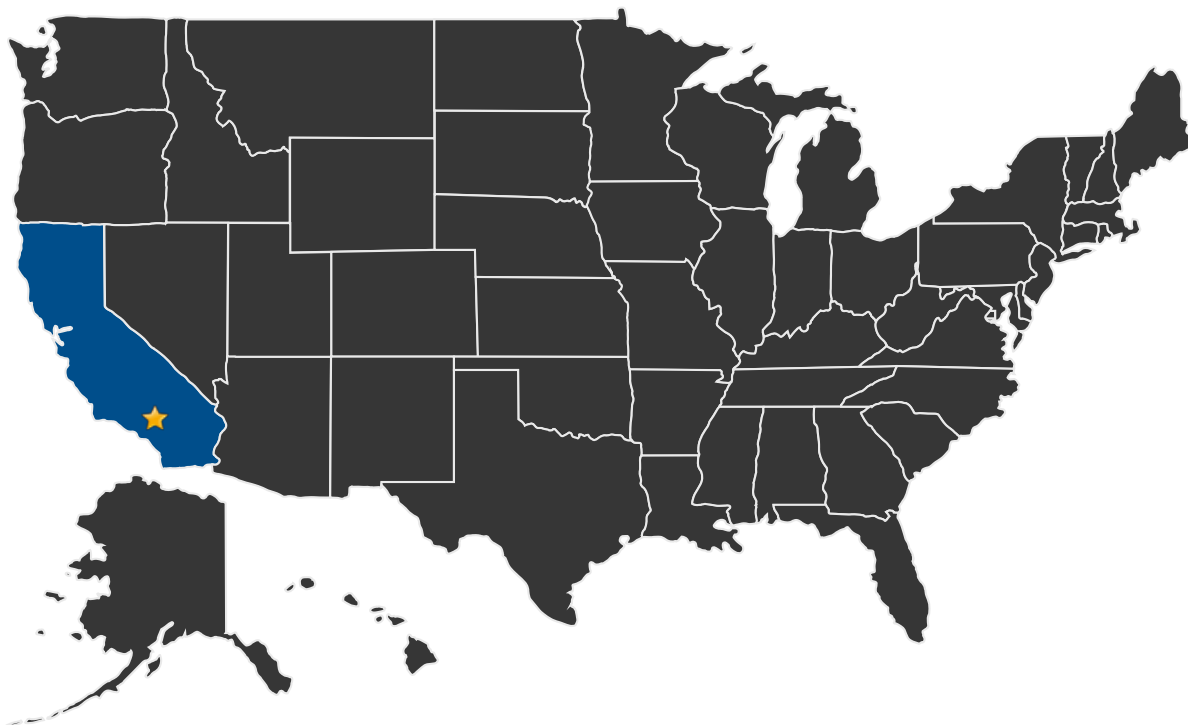
- Aeronautics (TA 15)
- Ultra-Efficient Commercial Vehicles (TA 15.3)

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U.S. WORK LOCATIONS AND KEY PARTNERS



■ U.S. States With Work

★ **Lead Center:**
Armstrong Flight Research Center

LATEST SUCCESS STORY

Intelligent Control for Performance Success story

PROJECT LIBRARY

Success Stories

- Intelligent Control for Performance Success story
 - (<http://techport.nasa.gov:80/file/17640>)

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DETAILS FOR TECHNOLOGY 1

Technology Title

Peak-Seeking Control for Trim Optimization

Technology Description

This technology is categorized as complex electronics software for manned flight

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Capabilities Provided

In contrast, this innovation determines in real time the most fuel-efficient trim surface position by taking into account actual flight conditions and an aircraft's physical condition. This customized approach results in maximum fuel efficiency for each particular aircraft.

Future flight research efforts will work to further mature the technology and transition it to other aircrafts. For example, the team is current working with the U.S. Navy to study the potential benefits and costs of implementing the technology on the Super Hornet military aircraft. The group is also talking with the Navy and Lockheed Martin about testing the technology on the F-35 fighter jet.

Potential Applications

- **Fuel-efficient:** Reduces fuel consumption and extends the operating range of aircrafts
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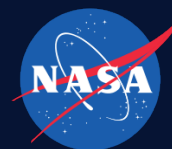
Applications

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Active Project

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Performance Metrics

Metric	Unit	Quantity
Fuel Efficient	%	3